SECURITY DOCUMENT INCLUDING A NANOPARTICLE-BASED AUTHENTICATION DEVICE

The present invention relates to security documents such as banknotes, credit cards and other documents of value, and is particularly concerned with providing a security document with an authentication device for verifying the authenticity of the security document. The invention is also concerned with a method of producing such security documents.

The counterfeiting of currency, stocks, bonds, credit cards and other valuable documents essential to conduct business and financial activities is a continuing serious problem. The widespread availability of high quality imaging systems and the increasing technological sophistication of counterfeiters increases the difficulty of combatting all forms of counterfeiting.

Currently, considerable resources are devoted to the development of devices for incorporation into a security document which can be detected to validate the document's authenticity. Holograms, opaque print strips and microprinting are examples of such devices, and their effectiveness depends upon the difficulties involved in counterfeiting them.

An aim of the present invention is to provide an authentication device for incorporation in a security document which acts to effectively circumvent counterfeiting of the security document.

With that in mind, one aspect of the present invention provides a security document comprising a sheet-like substrate having one or more layers containing particles for forming an authentication device in a first location on the security document, the particles having at least a first dimension in the range of 1 to 200 nanometers.

The particles may be substantially spherical. In another embodiment, the particles may be elongated. In a third embodiement, the particles may be a series of spherical particles concatenated together, in the form of "beads-over-string". In the case of elongated particles, at least a first group of the particles may be aligned so that their longitudinal axes are substantially parallel. The longitudinal axis of

Figure 10 is a schematic plan view showing a lined particle suitable for use in a security document according to the present invention;

Figure 11 is a schematic plan view of particles encapsulated in a clear transparent material for use in a security document according to the present invention;

Figure 12 is a cross-sectional side view of a fourth embodiment of a security document according to the present invention;

Figure 13 is a cross-sectional side view of a fifth embodiment of a security document according to the present invention;

Figure 14 is a schematic diagram showing a first method of locating particles in a substrate so as to form a security document according to the present invention; and

Figure 15 is a schematic diagram showing a second method for enabling the location of particles in a substrate so as to form a security document according to the present invention.

Referring now to Figure 1, there is shown generally a banknote 1 comprising a sheet-like substrate 2 preferably of plastics material and having first and second opposing surfaces 3 and 4. Various indicia may be formed on at least one of the first and second opposing surfaces 7 and 8, such as drawings, writing and other designs well known to manufacturers and users of banknotes.

The substrate is preferably a composite made from at least biaxially oriented polymeric film 5 which is coated on both sides with an opacifying pigmentry coating 6 and 7 comprising a major portion of pigment in a minor portion of cross-linked polymeric binder. A transparent protective coating (not shown) is preferably applied to both sides of the banknote 1 in order to protect it from wear. The transparent protective layer may include silica or like particles so as to improve the adherence of the banknote 1 when handled by a user.

The substrate 2 includes copolymer outer coatings 8 and 9 of the biaxially oriented polymeric film 5. An authentication device 10 is formed at a first location on the banknote 1 by the inclusion of nanoparticles in at least a portion of the copolymer outer coating 8. These nanoparticles have at least a first dimension

in the range of 1 to 200 nanometers, and, when included in a security document, provide a number of features suitable for use as an authentication device, as will be explained below.

The opacification layer 6 of the banknote 1 does not extend over the entire surface 3 of the substrate 2, but leaves a portion of the substrate 2 uncovered in the vicinity of the authentication device 10. This embodiment of the authentication device 10 takes advantage of particular optical effects of the nanoparticles included in the copolymer outer layer 8 or otherwise visible by a user. In this example, nanoparticles made from gold or other material which scatters and absorbs incident light waves are used in the authentication device 10. Nanoparticles of this type have been observed to exhibit isotropic absorption of incident light waves, their absorption spectrum being a function of both their aspect ratio, that is to say the ratio of their length to width, and their orientation. The absorption spectra for such nanoparticles in solution each having the same width of 10 nanometers but having different lengths is shown in Figure 4. It has been observed that the short-axis polarized band, indicated by the reference "S" does not change in position, whereas the long-axis polarized band, indicated by the reference "L", shifts to a longer wavelength as the length of the nanoparticles increases. In the simplest case, nanoparticles of a spherical shape may be used in the authentication device 10. Such gold nanospheres have been observed to exhibit a colour shift in reflection as a function of the viewing angle α. Such an authentication device will have a typical "green-golden" colour when viewed under specular reflection and appears red-crimson when viewed in diffuse reflectance. The actual "red-crimson" colour which is viewed in diffuse reflectance will depend upon the actual size of the nanosphere and on the thickness of any coating on it.

Alternatively, nanorods, nanoellipsoids or other elongated nanoparticles may be used in order to alter the colour observed by a user both under specular reflection and by diffuse reflectance of light on the surface of the authentication device 10.